CLAIMS

What is Claimed is:

1. A method of estimating a communication channel impulse response $h(t)$, comprising the steps of:

generating a data sequence d_i having a constrained portion Cd_i associated with at least two codes w_0, w_1, wherein a correlation $A_{code}(k)$ of the constrained portion Cd_i with one of the codes w_0, w_1 is characterized by a maximum value at $k = 0$ less than maximum values at $k \neq 0$;

generating a chip sequence c_j having a chip period T_c as the data sequence d_i spread by a spreading sequence S_i of length N;

generating $co_m(t) = co(t + mNT_c)$ for $m = 0,1,\Lambda ,M$ by correlating a received signal $r(t)$ with the spreading sequence S_i, wherein the received signal $r(t)$ comprises the chip sequence c_j applied to the communication channel; and

generating an estimated communication channel impulse response $\hat{h}_M(t)$ as a combination of $co_m(t)$ and d_m for $m = 0,1,\Lambda ,M$.

2. The method of claim 1, wherein the step of generating an estimated communication channel impulse response $\hat{h}_M(t)$ as a combination of $co_m(t)$ and d_m for $m = 0,1,\Lambda ,M$ comprises the step of computing $\hat{h}_M(t)$ as $\frac{1}{M}\sum_{m=0}^{M-1} d_m \bullet co(t + mNT_c)$.

3. The method of claim 2, wherein the at least two codes w_0, w_1 are each two symbols in length and wherein M=2.

4. The method of claim 1, wherein the data sequence d_i includes a preamble having a pseudorandom code including the constrained portion of the data sequence d_i.

5. The method of claim 1, wherein $A_{code}(k) = 1$ at $k = 0$ and $A_{code}(k) = 0$ for substantially all $k \neq 0$.

6. The method of claim 1, wherein $A_{code}(k) = 0$ for $0 < |k| \leq J$, wherein J is selected to minimize the correlation of the constrained portion Cd_i with the one of the codes w_0, w_1 for substantially all $k \neq 0$.

7. The method of claim 6, wherein $2J$ is a length of the constrained portion Cd_i.

8. The method of claim 1, wherein $A_{code}(k) = 1$ at $k = 0$ and $A_{code}(k) \approx 0$ for substantially all $k \neq 0$.

9. The method of claim 1, wherein each of the two codes w_0, w_1 comprises two symbols.

10. The method of claim 1, wherein the each of the two codes w_0, w_1 consists of two symbols.

11. The method of claim 1, wherein the codes w_0, w_1 comprise Walsh codes.

12. The method of claim 1, further comprising the step of filtering the estimated communication channel impulse response $\hat{h}_M(t)$ with a filter f selected at least in part according to the spreading sequence S_i.

13. The method of claim 12, wherein the filter f is further selected at least in part according to an autocorrelation $A(n)$ of the spreading sequence S_i.

14. The method of claim 13, wherein the filter f is further selected at least in part according to a duration of the impulse response of the communication channel $h(t)$.

15. The method of claim 13, wherein the filter f is further selected at least in part according to a zero-forcing criteria $\sum_{i=-L}^{L}(A(n-i)\bullet f(i) = A_f(n), -L \leq n \leq L$, wherein:

$f(i)$ is the impulse response of the filter f such that $A_f(n)$ is a convolution of $A(n)$ and $f(i)$;

$A_f(n) = 1$ for $n = 0$ and $A_f(n) = 0$ for $0 < |n| \leq L$; and

$A(n) = A(-n) = \sum_{i=o}^{N-1-n} S_i \bullet S_{i+n}, 0 \leq n \leq N$, and N is a length of the spreading sequence S_i.

16. The method of claim 15, wherein the parameter L is chosen such that a time duration of the impulse response of the communication channel $h(t)$ is less than LT_c.

17. The method of claim 15, wherein the parameter L is chosen such that a time duration of the impulse response of the communication channel $h(t)$ is approximately equal to LT_c.

18. The method of claim 12, wherein N is less than 20.

19. An apparatus for estimating a communication channel impulse response $h(t)$, comprising:

means for generating a data sequence d_i having a constrained portion Cd_i associated with at least two codes w_0, w_1, wherein a correlation $A_{code}(k)$ of the constrained portion Cd_i with one of the codes w_0, w_1 is characterized by a maximum value at $k = 0$ less than maximum values at $k \neq 0$;

means for generating a chip sequence c_j having a chip period T_c as the data sequence d_i spread by a spreading sequence S_i of length N;

means for generating $co_m(t) = co(t + mNT_c)$ for $m = 0,1,\Lambda\ ,M$ by correlating a received signal $r(t)$ with the spreading sequence S_i, wherein the received signal $r(t)$ comprises the chip sequence c_j applied to the communication channel; and

means for generating an estimated communication channel impulse response $\hat{h}_M(t)$ as a combination of $co_m(t)$ and d_m for $m = 0,1,\Lambda\ ,M$.

20. The apparatus of claim 19, wherein the means for generating an estimated communication channel impulse response $\hat{h}_M(t)$ as a combination of $co_m(t)$ and d_m for $m = 0,1,\Lambda\ ,M$ comprises means for computing $\hat{h}_M(t)$ as $\frac{1}{M}\sum_{m=0}^{M-1} d_m \bullet co(t + mNT_c)$.

21. The apparatus of claim 20, wherein the at least two codes w_0, w_1 are each two symbols in length and wherein $M=2$.

22. The apparatus of claim 19, wherein the data sequence d_i includes a preamble having a pseudorandom code including the constrained portion of the data sequence d_i.

23. The apparatus of claim 19, wherein $A_{code}(k) = 1$ at $k = 0$ and $A_{code}(k) = 0$ for substantially all $k \neq 0$.

24. The apparatus of claim 19, wherein $A_{code}(k) = 0$ for $0 < |k| \leq J$, wherein J is selected to minimize the correlation of the constrained portion Cd_i with the one of the codes w_0, w_1 for substantially all $k \neq 0$.

25. The apparatus of claim 24, wherein $2J$ is a length of the constrained portion Cd_i.

26. The apparatus of claim 19, wherein $A_{code}(k) = 1$ at $k = 0$ and $A_{code}(k) \approx 0$ for substantially all $k \neq 0$.

27. The apparatus of claim 19, wherein each of the two codes w_0, w_1 comprises two symbols.

28. The apparatus of claim 19, wherein the each of the two codes w_0, w_1 consists of two symbols.

29. The apparatus of claim 19, wherein the codes w_0, w_1 comprise Walsh codes.

30. The apparatus of claim 19, further comprising the step of filtering the estimated communication channel impulse response $\hat{h}_M(t)$ with a filter f selected at least in part according to the spreading sequence S_i.

31. The apparatus of claim 30, wherein the filter f is further selected at least in part according to an autocorrelation $A(n)$ of the spreading sequence S_i.

32. The apparatus of claim 31, wherein the filter f is further selected at least in part according to a duration of the impulse response of the communication channel $h(t)$.

33. The apparatus of claim 31, wherein the filter f is further selected at least in part according to a zero-forcing criteria $\sum_{i=-L}^{L}(A(n-i) \bullet f(i) = A_f(n), -L \leq n \leq L$, wherein:

$f(i)$ is the impulse repsonse of the filter f such that $A_f(n)$ is a convolution of $A(n)$ and $f(i)$;

$A_f(n) = 1$ for $n = 0$ and $A_f(n) = 0$ for $0 < |n| \leq L$; and

$A(n) = A(-n) = \sum_{i=o}^{N-1-n} S_i \bullet S_{i+n}, 0 \leq n \leq N$, and N is a length of the spreading sequence S_i.

34. The apparatus of claim 33, wherein the parameter L is chosen such that a time duration of the impulse response of the communication channel $h(t)$ is less than LT_c.

35. The apparatus of claim 33, wherein the parameter L is chosen such that a time duration of the impulse response of the communication channel $h(t)$ is approximately equal to LT_c.

36. The apparatus of claim 30, wherein N is less than 20.

37. An apparatus for estimating a communication channel impulse response $h(t)$, comprising:

means for generating a data sequence d_i having a constrained portion Cd_i associated with at least two codes w_0, w_1, wherein a correlation $A_{code}(k)$ of the constrained portion Cd_i with one of the codes w_0, w_1 is characterized by a maximum value at $k = 0$ less than maximum values at $k \neq 0$;

means for generating a chip sequence c_j having a chip period T_c as the data sequence d_i spread by a spreading sequence S_i of length N;

a correlator for generating $co_m(t) = co(t + mNT_c)$ for $m = 0,1,\Lambda ,M$ by correlating a received signal $r(t)$ with the spreading sequence S_i, wherein the received signal $r(t)$ comprises the chip sequence c_j applied to the communication channel; and

an estimator for generating an estimated communication channel impulse response $\hat{h}_M(t)$ as a combination of $co_m(t)$ and d_m for $m = 0,1,\Lambda ,M$.

38. The apparatus of claim 37, wherein the estimator comprises means for computing $\hat{h}_M(t)$ as $\frac{1}{M}\sum_{m=0}^{M-1} d_m \bullet co(t + mNT_c)$.

39. The apparatus of claim 38, wherein the at least two codes w_0, w_1 are each two symbols in length and wherein M=2.

40. The apparatus of claim 37, wherein the data sequence d_i includes a preamble having a pseudorandom code including the constrained portion of the data sequence d_i.

41. The apparatus of claim 37, wherein $A_{code}(k) = 1$ at $k = 0$ and $A_{code}(k) = 0$ for substantially all $k \neq 0$.

42. The apparatus of claim 37, wherein $A_{code}(k) = 0$ for $0 < |k| \leq J$, wherein J is selected to minimize the correlation of the constrained portion Cd_i with the one of the codes w_0, w_1 for substantially all $k \neq 0$.

43. The apparatus of claim 42, wherein $2J$ is a length of the constrained portion Cd_i.

44. The apparatus of claim 37, wherein $A_{code}(k) = 1$ at $k = 0$ and $A_{code}(k) \approx 0$ for substantially all $k \neq 0$.

45. The apparatus of claim 37, wherein each of the two codes w_0, w_1 comprises two symbols.

46. The apparatus of claim 37, wherein the each of the two codes w_0, w_1 consists of two symbols.

47. The apparatus of claim 37, wherein the codes w_0, w_1 comprise Walsh codes.

48. The apparatus of claim 37, further comprising the step of filtering the estimated communication channel impulse response $\hat{h}_M(t)$ with a filter f selected at least in part according to the spreading sequence S_i.

49. The apparatus of claim 48, wherein the filter f is further selected at least in part according to an autocorrelation $A(n)$ of the spreading sequence S_i.

50. The apparatus of claim 49, wherein the filter f is further selected at least in part according to a duration of the impulse response of the communication channel $h(t)$.

51. The apparatus of claim 49, wherein the filter f is further selected at least in part according to a zero-forcing criteria $\sum_{i=-L}^{L}(A(n-i) \bullet f(i) = A_f(n), -L \leq n \leq L$, wherein:

$f(i)$ is the impulse repsonse of the filter f such that $A_f(n)$ is a convolution of $A(n)$ and $f(i)$;

$A_f(n) = 1$ for $n = 0$ and $A_f(n) = 0$ for $0 < |n| \leq L$; and

$A(n) = A(-n) = \sum_{i=o}^{N-1-n} S_i \bullet S_{i+n}, 0 \leq n \leq N$, and N is a length of the spreading sequence S_i.

52. The apparatus of claim 51, wherein the parameter L is chosen such that a time duration of the impulse response of the communication channel $h(t)$ is less than LT_c.

53. The apparatus of claim 51, wherein the parameter L is chosen such that a time duration of the impulse response of the communication channel $h(t)$ is approximately equal to LT_c.

54. The apparatus of claim 48, wherein N is less than 20.